Icetop integration into IceCube DAQ

- IceTop schedule. phase I
- Integration into documentation, production, testing…
- Comparison of block diagrams (Icetop DD vs SDD)
  - General trigger
  - "String Processor"
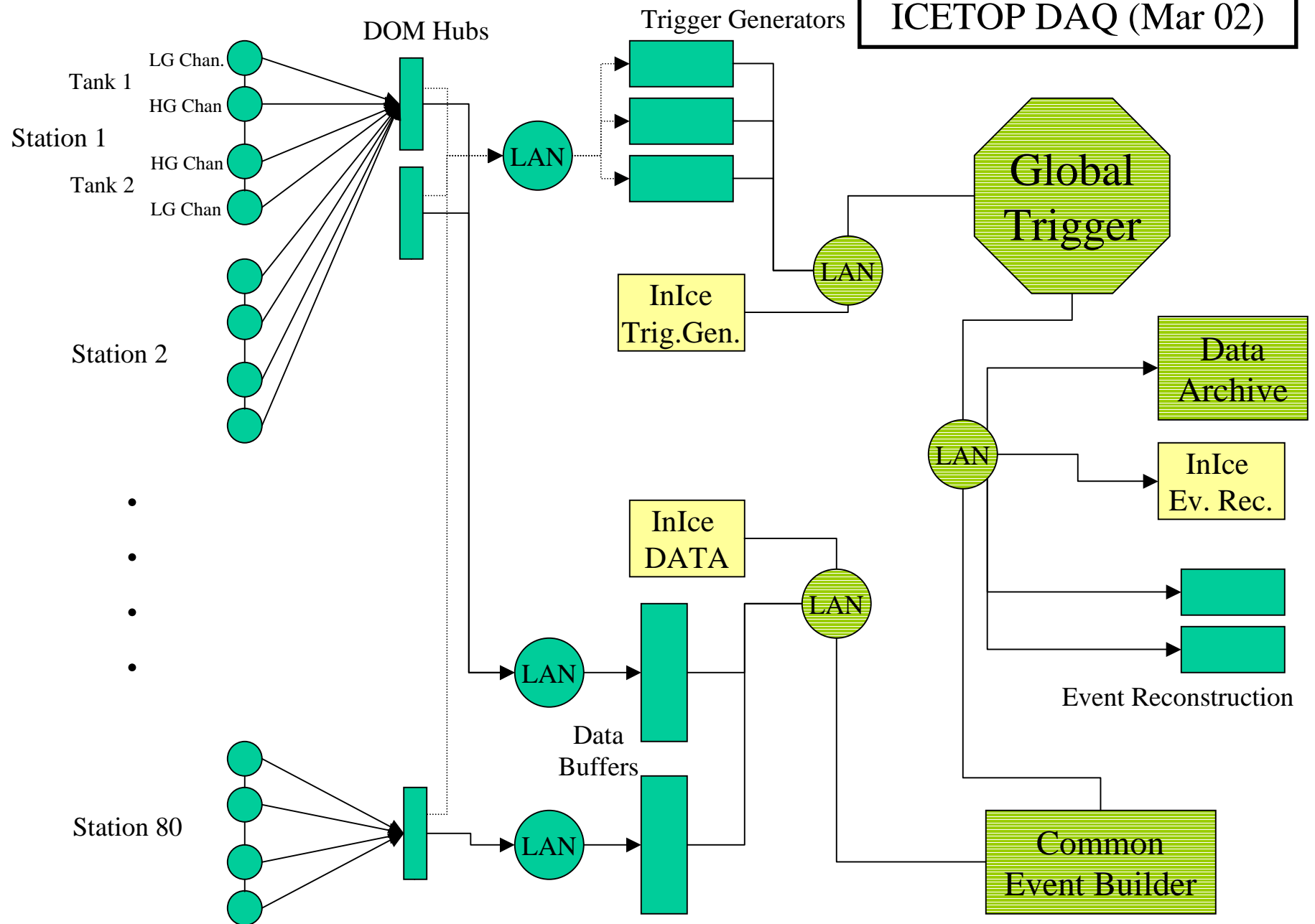- Functional differences

IceTop Phase 1.

- Engineering development for clear ice tanks
- Firmware and DAQ integration
- Air shower and tank simulation

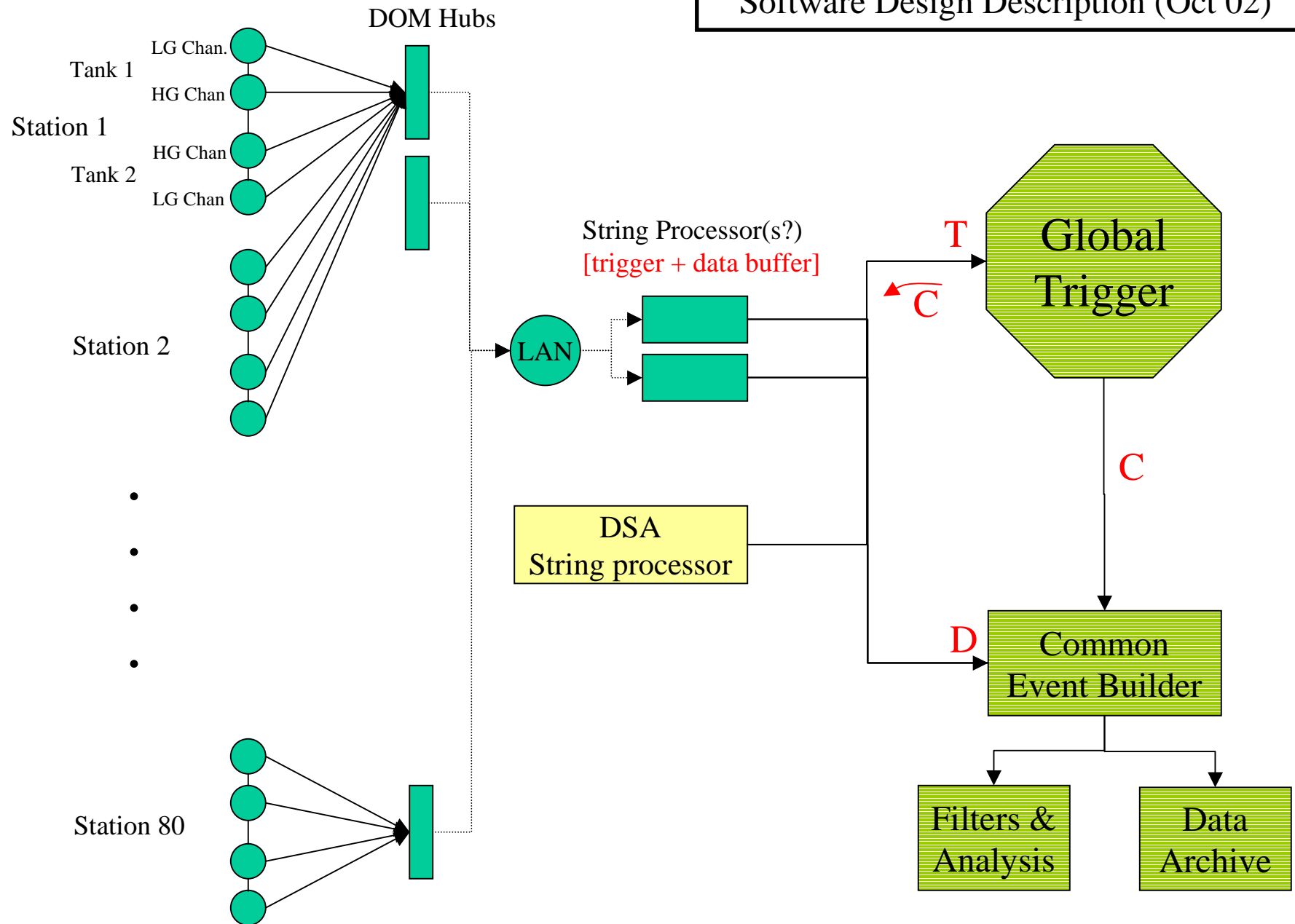- phase II, III ? (I'm not prepared – sorry)

Documentation, Production & Testing

- Inline or parallel documents?
  - coauthor or in draft/comment phase?
  - signoff?

- Separate production run(s) ?
  - High gain and low gain DOMs
  - low numbers – modify after production?

- Separate testing procedures
  - Separate framework or modified
  - 80% same, 10% modified, 10% unique ?

ICETOP DAQ (Mar 02)

Software Design Description (Oct 02)

DOM Hubs

Station 1
- Tank 1: LG Chan., HG Chan
- Tank 2: HG Chan, LG Chan

Station 2

Station 80

LAN

String Processor(s?)
[trigger + data buffer]

T

C

Global Trigger

C

DSA String processor

D

Common Event Builder

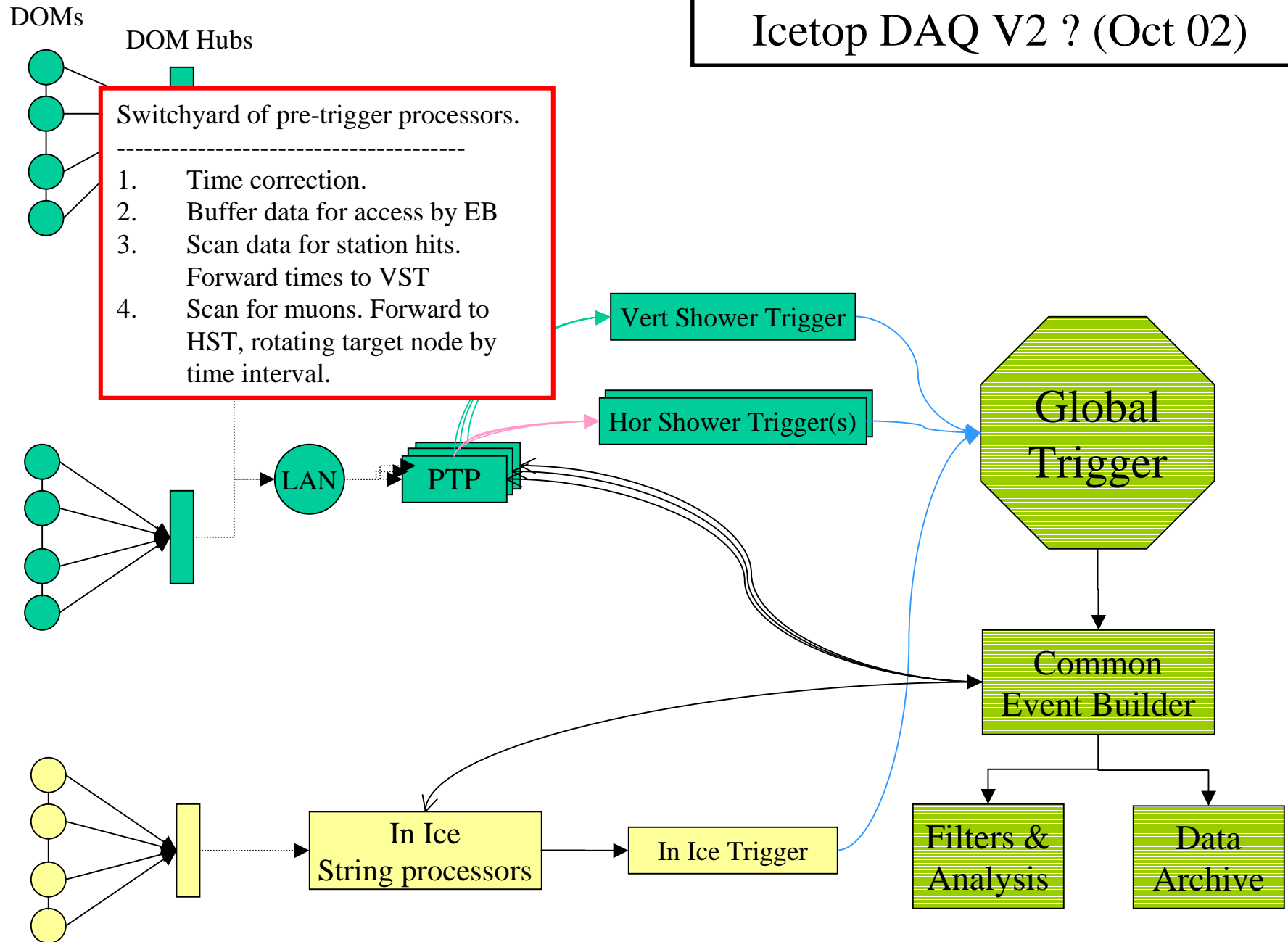Filters & Analysis

Data Archive

Differences

- ## Global Trigger
  - no three way communications
  - flexibility to link/add additional components
    - SPASE/AMANDA, Acoustics/Radio/Air Cherenkov
    - engineering triggers

- ## Trigger + Data Buffer
  - Two triggers (icetop global)
    - Vertical showers (coincident station hits)
    - Horizontal showers (single tank muons) – challenging
  - DBs: probably need multiple buffers to handle bandwidth

Issues with Icetop DAQ, Mar 02

1. Time correction?

2. Hub should not touch data --- just forward it.

3. Why multiple data buffers ?

4. and trigger generators?

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1. TC is a String processor not a HUB function. Therefore there needs to be a box between Hubs and triggers.

2. Hub should have just one upstream destination

3. Total data volume 100 KBps * 320 = 320 Mbps, cf. fast ethernet 100 Mbps – multiple buffers to absorb data

4. Verticle trigger: Station triggers max 100 Hz, -> 16 KHz of data to be searched for coincidences. data rate = 1.6 Mbps.

5. Horizontal trigger: Single tank triggers max 2500 Hz -> 400 KHz to be searched. data rate = 40 Mbps. May need multiple nodes for processing and/or bandwidth.

DOMs

DOM Hubs

Switchyard of pre-trigger processors.
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1.   Time correction.
2.   Buffer data for access by EB
3.   Scan data for station hits.
     Forward times to VST
4.   Scan for muons. Forward to
     HST, rotating target node by
     time interval.

Icetop DAQ V2 ? (Oct 02)

LAN

PTP

Vert Shower Trigger

Hor Shower Trigger(s)

Global
Trigger

Common
Event Builder

In Ice
String processors
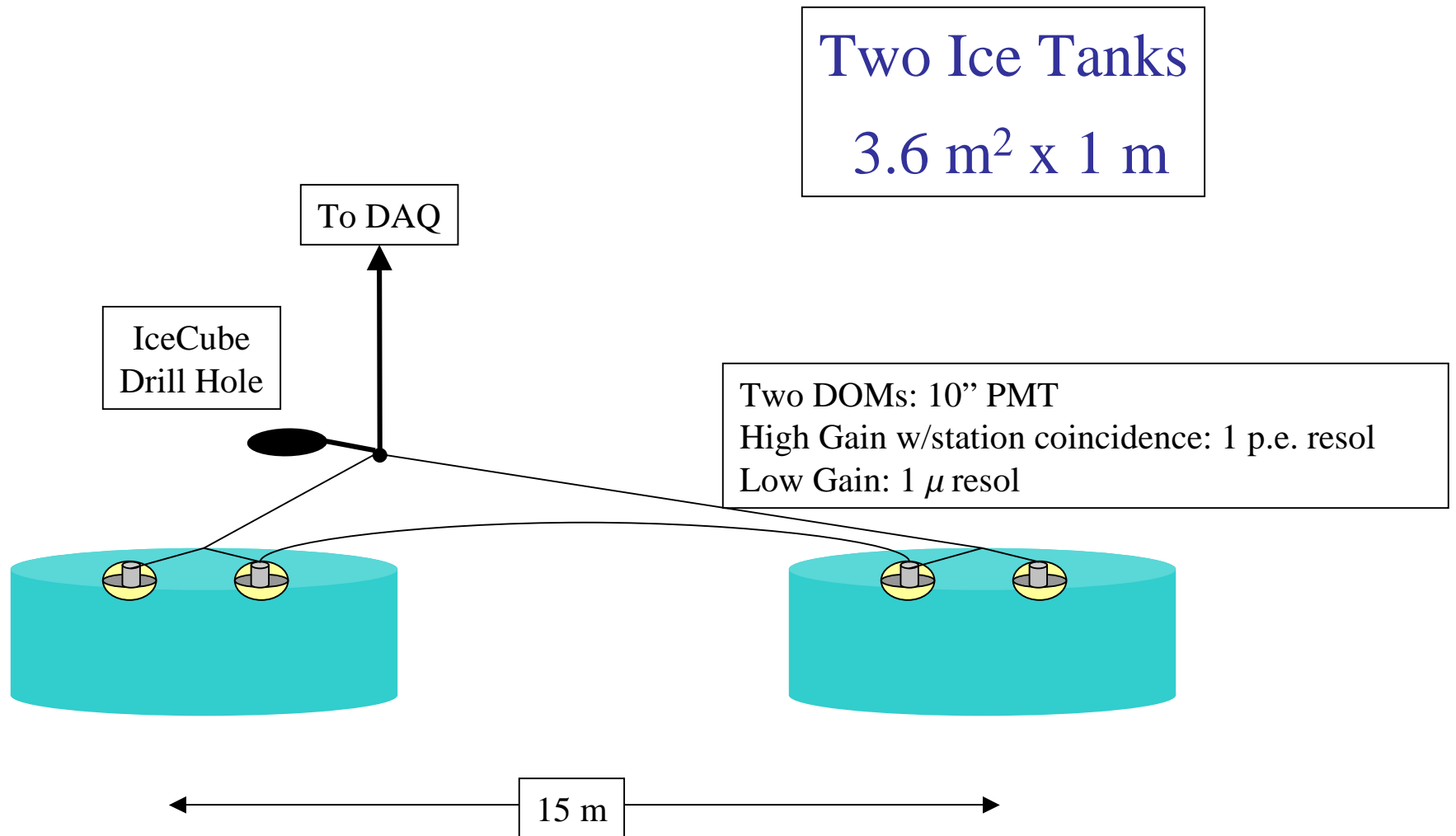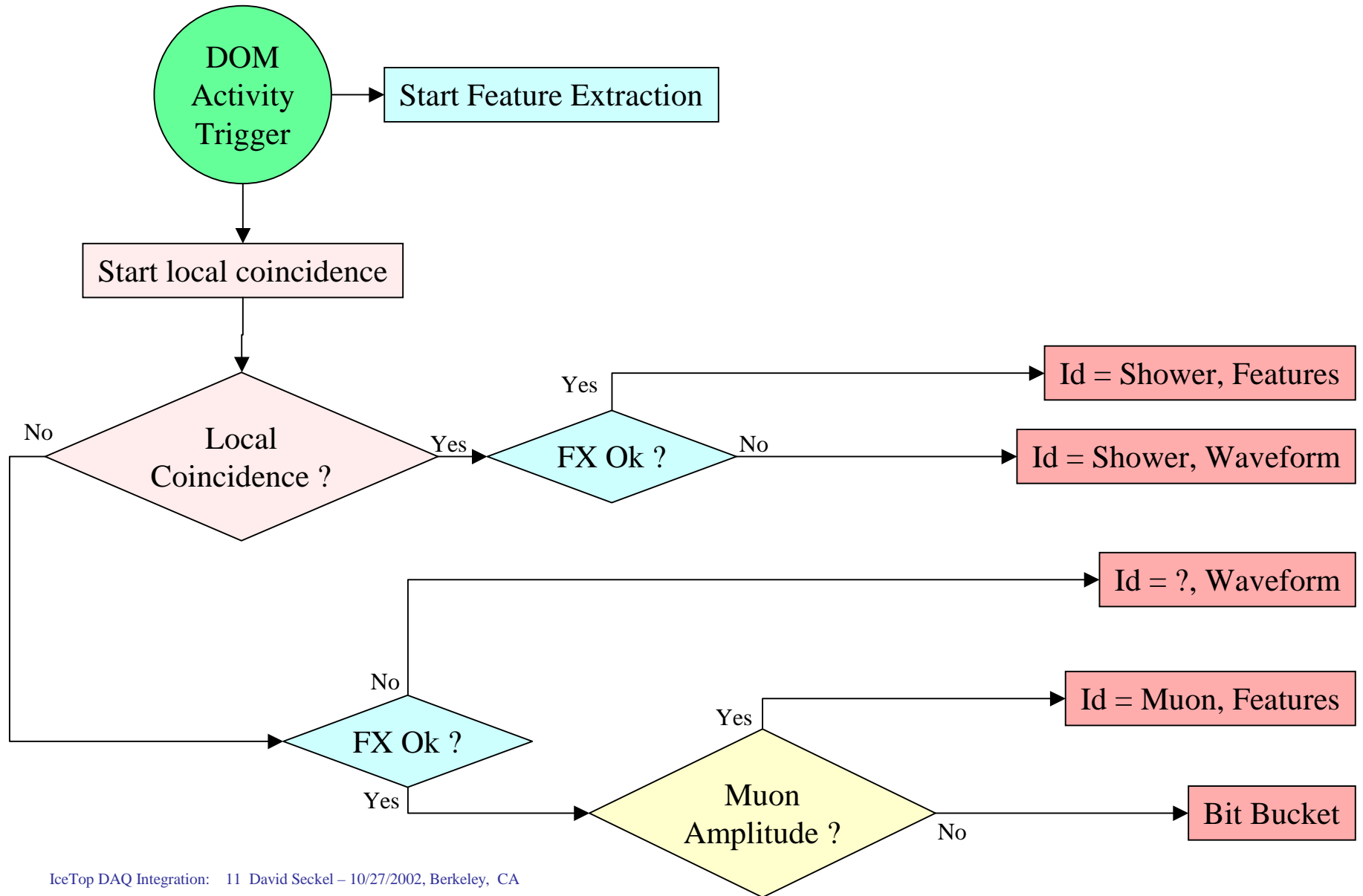
In Ice Trigger

Filters &
Analysis

Data
Archive

Functional differences…

- High Gain/Low Gain DOMs
- Firmware
  - two types of events
  - feature extraction
  - coincidence logic between tanks
- Communication (speed 100 KBps vs 20/40), 1 DOM per wire pair)
- Thermal control (min T or ΔT?)
- Noise environment?

IceTop Station Schematic

Two Ice Tanks

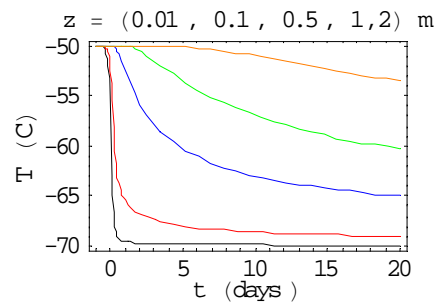$3.6 \text{ m}^2 \times 1 \text{ m}$

To DAQ

IceCube
Drill Hole

Two DOMs: 10" PMT
High Gain w/station coincidence: 1 p.e. resol
Low Gain: 1μ resol

15 m

IceTop DOM Strategy

DOM Activity Trigger → Start Feature Extraction

DOM Activity Trigger → Start local coincidence

Local Coincidence ?
- No →
- Yes → FX Ok ?
  - Yes → Id = Shower, Features
  - No → Id = Shower, Waveform

FX Ok ?
- No → Id = ?, Waveform
- Yes → Muon Amplitude ?
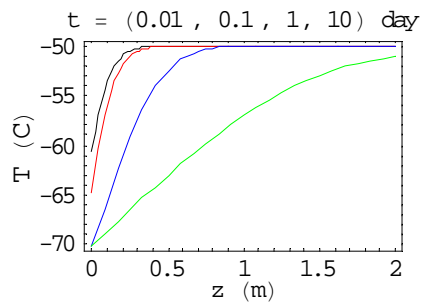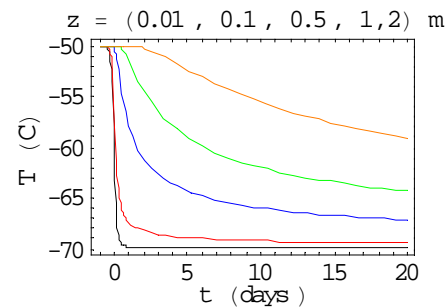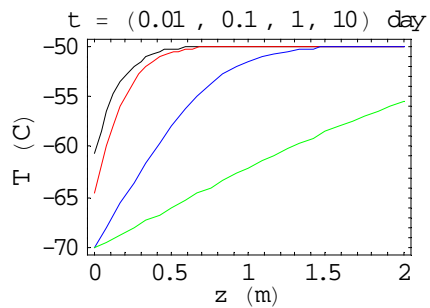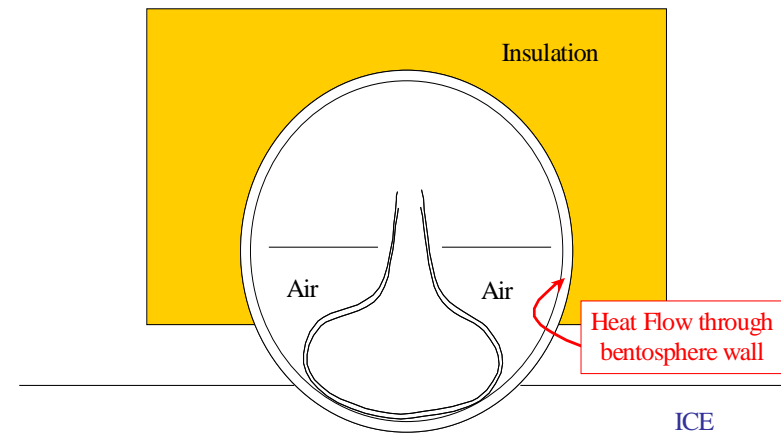 - Yes → Id = Muon, Features
  - No → Bit Bucket

IceTop Data Return Strategy

- Singles (Muons + $E_e > 30$ MeV)
  - id (2), time (4), fit parameters(6) – 12 bytes
  - 2500 Hz * 12 B = 30 KBps/DOM

- Soft Component
  - Check for local coincidence (two tanks)
  - $R_{showers}$ ~ 10-100 Hz
  - $R_{uncorrelated\ coincidence}$ ~ 10-100 Hz
  - Mostly simple fits – 2 KBps/DOM

- Waveform
  - 5% simple fit fails ~ 100 Hz
  - Scaled selection of minimum bias and event triggers ~ 10 Hz
  - Compress and return complete waveform ~ 100 B
  - 200 Hz * 100 B = 20 KBps/DOM

Thermal issues

Passive design to keep DOM MB 25C
warmer than ice in tank.

Insulation

Air   Air

Heat Flow through
bentosphere wall

ICE

t = (0.01 , 0.1 , 1, 10) day

z = (0.01 , 0.1 , 0.5 , 1, 2) m

Thermal time scales for
non-insulated
and insulated tanks

t = (0.01 , 0.1 , 1, 10) day

z = (0.01 , 0.1 , 0.5 , 1, 2) m